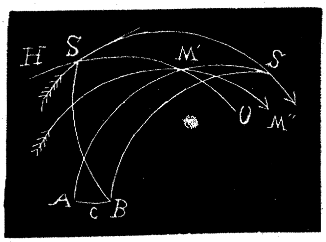
limb, and refraction, be considered the days will be 187 or 188. The answer for 41° N. is *good* for *any* other latitude north, while the problem seems to imply that an answer for 41° is different for other latitudes.

54. Proposed by S. HART WRIGHT, M. D., A. M., Ph. D., Penn Yan, N. Y.

On latitude 40° N.$=\lambda$, when the Moon's declination is 5° 23′ N.$=\delta$, and the Sun's 9° 52′ S.$=-\delta$, how long after sunset will the two horns or cusps of the Moon's crescent (recently new) set at the same moment, the crescent with its back *down* having touched the horizon first? Semi-diameters, refraction, and parallax not considered.

I. Solution by the PROPOSER.

Let B be the celestial north pole, A the zenith, AB an arc of the meridian equal the co-latitude$=c=50°$, HO a portion of the horizon, SS' and MM'' portions of the diurnal arcs of the Sun and Moon, the Sun setting at S, and the Moon at M'; BS=the polar distance of the Sun$=BS'$, and BM' the polar distance of the Moon, and AM' the zenith distance of the Moon$=90°$.



Produce the vertical circle AM' to S', S' being the place of the Sun when the Moon sets at M'. The line joining the Moon's cusps must be at right angles to the line $M'S'$ joining the centers of the Sun and Moon, and as the horison is at right angles to $AM'S'$, the line of the cusps must lie on the horizon and set when the Moon's center sets. Put $\angle ABS=\phi$=Sun's hour angle when it sets, and $\angle ABS'=\theta$= Sun's hour angle when the Moon sets, and $\angle ABM'=\psi$=Moon's hour angle when it sets.

Then we have $\cos\phi=\tan\delta'\tan\lambda$. $\therefore$ $\phi=81°\ 36'\ 29''$, and $\cos\psi=-\tan\delta\tan\lambda$. $\therefore$ $\psi=94°\ 32'\ 7''$. Take an auxiliary arc χ', and $\tan\chi'=\cos\psi\cot\delta$. $\therefore$ $\chi'=40°\ 0'\ 1''$, then $\cot A=\sin(c-\chi')\cot\psi\operatorname{cosec}\chi'$. $\therefore$ $A=82°\ 57'\ 55''$. Take an auxiliary angle γ', and $\cot\gamma'=\tan A\sin\lambda$. $\therefore$ $\gamma'=10°\ 52'\ 2''$. Then $\cos\gamma'\cot\lambda\tan-\delta'=-\cos\gamma$. $\therefore$ $\gamma=101°\ 44'\ 43''$, and $\angle ABS'=\gamma'+\gamma=\theta=112°\ 36'\ 45''$, and $\theta-\phi=31°\ 0'\ 16''$=2 hours, 4 minutes, 1 second.

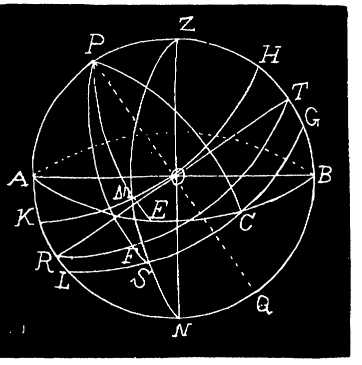
NOTE. The synchronous setting or rising of the cusps of a crescent Moon, is a phenomenon which must occur frequently in the tropics, and rarely or not at all beyond latitude 45°. On the 4th of July, 1897, such a moonset was very nearly accomplished, and another, almost perfect, will occur February 22, 1898, the declinations being then as given in the problem. Few persons in the northern states have ever seen the Moon set with both horns vertical.

II. Solution by G. B. M. ZERR, A. M., Ph. D., President and Professor of Mathematics, The Russell College, Lebanon, Va.

Let O be the observer, Z his zenith, HMK Moon's path, $GCSL$ Sun's path, $TEFR$ celestial equator, $AMCB$ the horizon. Let M be the position of the Moon when setting. Then, in order that the horns may set at the same time, S, M, where S is the Sun, must be on the same meridian, $ZMSN$.

$AP=\lambda=40°$. $ME=\delta=5°\ 23'$ N. $SF=\delta_1=9°\ 52'$ S. In the triangle

PMZ, $PZ=90^\circ-\lambda_1$, $ZM=90^\circ$, $PM=90^\circ-\delta$. Let $\angle ZPM=h$, $\angle PZM=z$, $ZPC=h_1$, $\angle ZPS=\beta$.



Then $\cos h=-\tan\lambda\tan\delta=-\tan 40^\circ \tan 5^\circ 23'$. $\therefore h=94^\circ\ 32'\ 6.8''$.

$\sin z=\cos\delta\sin h$. $\therefore z=82^\circ\ 57'\ 54''$.

$\cos h_1=-\tan\lambda\tan\delta_1$. $\therefore h_1=81^\circ\ 36^\circ\ 29$.

In triangle ZPS, $PS=90^\circ+\delta_1$, $PZ=90^\circ-\lambda$. $\angle PZS=z$.

$\sin PSZ=(\sin z\cos\lambda)/\cos\delta_1$. $\therefore PSZ=\lambda_1=50^\circ\ 30'\ 22''$.

$$\cot\tfrac{1}{2}\beta=\frac{\sin\frac{1}{2}(180^\circ-\lambda+\delta_1)}{\sin\frac{1}{2}(\lambda+\delta_1)}\tan\tfrac{1}{2}(z-\lambda_1).$$

$\therefore \beta=112^\circ\ 36'\ 47''$.

$\beta=$Sun's hour angle at moonset ; $h_1=$ Sun's hour angle at sunset ; $\beta-h_1=31^\circ\ 0'\ 18''=2$ hours, 4 minutes, 1.2 seconds after sunset.

PROBLEMS FOR SOLUTION.

ARITHMETIC.

89. Proposed by NELSON S. RORAY, South Jersey Institute, Bridgeton, N. J.

Solve by pure arithmetic. A criminal having escaped from prison traveled 10 hours before his escape was known; he was then pursued so as to be gained upon 3 miles an hour: after his pursuers had traveled 8 hours they met an express going at same rate as themselves, who had met the criminal 2 hours and 24 minutes before; in what time from the commencement of the pursuit will they overtake him?

90. Proposed by F. M. PRIEST, Mona House, St. Louis, Mo.

A owes \$6000 which is drawing 6% interest. He wishes to pay off the debt in six equal annual payments, the first to be due in one year. The whole portion of the claim unpaid at the end of each year to be accounted as principal, and to draw interest to the time of the next payment. Required the amount of each payment, so the six equal payments will discharge the obligation, interest and all.

91. Proposed by J. A. CALDERHEAD, M. Sc., Professor of Mathematics in Curry University, Pittsburg, Pa.

\$1000.00. Cleveland, Ohio, May 26, 1893.

Two years after date I promise to pay John Davis, or order, one thousand dollars, for value received, interest six per cent. payable annually. J. M. Lewis.

Indorsements: December 14, 1895, \$560.56; May 11, 1896, \$10.02; June 14, 1697, \$545.06.

Find, by the United States' Rule, the amount due August 2, 1897.

⁂ Solutions of these problems should be sent to B. F. Finkel, not later than March 1.